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High frequency yoga breathing (*kapalabhati*) and autonomic nervous system: a review of scientific literature

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ABSTRACT

Yoga practice places particular emphasis on voluntary breath regulation, as this is traditionally believed to influence brain functions. In yoga practice there are several ways in which a practitioner may voluntarily modify their respiration, which includes changing the rate, depth, and breathing through the mouth, among other methods. Modifying the rate of breathing is the basis for a particular technique called *kapalabhati*, which is a high frequency yoga breathing technique (with a breath rate of 1.0 to 2.0 Hz). This review article discussed the findings of scientific studies on the effects of high frequency yoga breathing (HFYB) on the autonomic nervous system. The observations made by the studies reviewed revealed that HFYB can influence the autonomic nervous system.

Keywords: Yoga; voluntary breath regulation; high frequency yoga breathing; autonomic nervous system

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INTRODUCTION

The nervous system of the human body has three main functions (i) sensory input (ii) integration of information and (iii) motor output (Ganong, 2005). It is comprised of two major subdivisions (a) the central nervous system (CNS) and (b) the peripheral nervous system (PNS). The PNS is subdivided into (i) the autonomic nervous system and (ii) the somatic nervous system (Ganong, 2005).

The autonomic nervous system innervates the smooth musculature of all organs, the heart and the glands and mediates the neuronal regulation of the internal environment (Janig, 2013).This system helps control arterial blood pressure, gastrointestinal motility and secretion, urinary bladder emptying, sweating, body temperature.

The ANS is a key stress regulatory system in the body, and exerts its effects on peripheral target organs via centres in the central nervous system (Critchley, 2005), including brainstem areas (e.g. the ventrolateral medulla and periaqueductal grey matter), the hypothalamus, and higher brain centres (e.g., the insular and anterior cingulate cortices) involved in cognitive and emotional regulation. The ANS is involved in adaptation through a regulation of various adaptive physiological and psychological processes, including cardiovascular regulation and pain (Martinez-Lavin, 2012). The ANS is constituted by two anatomically separate divisions: (i) the sympathetic nervous system and (ii) the parasympathetic nervous system. The most common neurotransmitters of the ANS are norepinephrine and epinephrine (adrenergic fibres) and acetylcholine (cholinergic fibres). In addition, sympathetic activation leads to the release of adrenal medullary epinephrine and norepinephrine in the blood. The sympathetic and Parasympathetic systems have typically antagonistic tonic effects on a given tissue, and their

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balance is essential for homeostasis. Although these systems usually act in a reciprocal manner, they can also be co-activated or independent (Berntson et al, 1994). The sympathetic nervous system prepares the body for physical or mental challenge − "Fight or Flight" − through a variety of physiological changes (e.g., enhanced respiration and increased heart rate, blood pressure and blood flow), which promote adaptation by increasing oxygenation and nutrition to the brain, heart and skeletal muscles. In contrast, parasympathetic nervous system activation generally promotes recuperative and anabolic processes, with a reduction in heart rate, a lowering of blood pressure and an increase in gut motility (Critchley, 2005). Thus, parasympathetic nervous system predominance will occur during periods of rest, most markedly during sleep, while the sympathetic nervous system predominates during the day when there are increasing demands, contributing to the circadian rhythm of the ANS (Bilan et al, 2005; Burgess et al, 1997) . A healthy ANS response to stressors is characterized by sympathetic activation and parasympathetic withdrawal, which is quickly recovered after cessation of the stressor.

Yoga practice places particular emphasis on voluntary breath regulation, as this is traditionally believed to influence brain functions (Muktibodhananda, 1993). In yoga practice there are several ways in which a practitioner may voluntarily modify their respiration, which includes changing the rate, depth, and breathing through the mouth, among other methods (Telles & Naveen, 2008). Voluntarily regulated yoga breathing (*pranayamas*) involves regulating the rate and depth of breathing and this can be done through several techniques (i) breathing through one or both nostrils (ii) increasing the depth of breathing (iii) breathing with a period of breath holding (iv) exhaling with the production of a sound (v) breathing through the mouth and (vi) increasing the rate of breathing.

Table 2: Features of breath regulation of different *pranayamas*

No.	Feature of breath regulation	Yoga technique
1	Rate	*Kapalabhati*
2	Depth	*Bhastrika*
3	Breath holding (*kumbhak*)	*Kumbhaka pranayamas* (e.g., *Ujjayi*)
4	Breathing through the mouth	*Sadanta, Sitali, Sitkari*
5	Breathing through one or both nostrils - alternately	*Surya, Chandra, anuloma viloma, nadisuddhi*
6	Breathing out with a sound	*Brahmari*, OM chanting

Modifying the rate of breathing is the basis for a particular technique called *kapalabhati*, which is a high frequency yoga breathing technique (with a breath rate of 1.0 to 2.0 Hz) (Saraswati, 1996). High frequency yoga breathing at 1.0 Hz is widely practiced for its health benefits (Anand, 2007). In this review we will discuss the observations made by scientific studies on high frequency yoga breathing are listed below.

HFYB AND AUTONOMIC NERVOUS SYSTEM

A study on twenty-four volunteers who practiced the technique at the rate of 2.0 Hz for 15 minutes, analyzed as three, five minute periods (Stancak, et al. 1991a). Respiratory movements, blood pressure and R-R intervals of ECG were recorded in parallel and evaluated by spectral analysis oftime series. A 0.1 Hz rhythm was present in the record of R-R intervals and the blood pressure during the HFYB. The results were taken to support the hypothesis about the integrative role of cardiovascular and respiratory rhythms when the respiratory frequency is altered. The same authors further assessed the effects of the HFYB (at 2.0 Hz) as three, five minute periods, as in their other study, in seventeen advanced yoga practitioners (Stancak, et al. 1991b). The EKG, respiration and blood pressure were recorded continuously during the three, five minute periods of HFYB, as well as before and after the practice. The beat to beat series of the R-R intervals as well as systolic and diastolic blood pressure were analyzed by a spectral analysis of the time series. All frequency bands of R-R interval variability were reduced in HFYB. These results as well as the changes in other variables point to decreased cardiac vagal modulation during HFYB.

A comparable result was reported when twelve experienced practitioners practiced HFYB technique at 2.0 Hz and alternate nostril breathing (*nadisuddhi pranayama*) for one minute on separate days and a frequency domain analysis was carried out (Raghuraj, et al. 1998). Following one minute of HFYB there was a significant increase in the low frequency power and in the LF/HF ratio, while the HF power was significantly lower following the HFYB. The results suggested that the HFYB modifies the autonomic status by increasing sympathetic activity with reduced vagal activity. There was no significant change after alternate nostril breathing.

The effect of HFYB on the cardiac autonomic control was hence reported to have comparable effects in two studies which differed in the duration of the practice i.e., fifteen minutes (Stancak, et al. 1991a) as compared to one minute (Raghuraj, et al. 1998).

However the finding of a more recent study on HFYB (Telles, et al. 2011) practice at 1.0 Hz showed that during HFYB there was a significant decrease in mean RR interval, NN50 and pNN50 when compared with pre-intervention. This study was conducted on 38 healthy volunteers and they were assessed for two interventions i) high frequency yoga breathing and ii) breath awareness on separate days. Each session was for 35 minutes with three epochs i.e., pre (5 minutes), during (15 minutes) and post (5 minutes). Comparison was made using repeated measures ANOVA. The study also reported that there was a significant decrease in mean RR interval when post-intervention was compared with pre, and in pNN50 when post-intervention was compared with pre.

CONCLUSION

The findings of the studies reviewed suggest that HFYB can influence the functioning of the autonomic nervous system. This may be due to the linked between respiratory centers and the autonomic nervous system in the brainstem. The pattern of change in the autonomic nervous system differed with the breath rate at which HFYB was practiced. HFYB practiced at the breath rate of 2.0 Hz increase the sympathetic activity and HFYB practices at the breath rate of 1.0 Hz caused parasympathetic withdrawal.

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